

## APPENDIX 3.F-

### Perspectives from a Detector Manufacturer

*Tim McCaffrey, Raytheon Commercial Infrared*

Imaging Core makers have promoted Pyroelectric sensors and MicroBolometers for use in the Fire Service/ First Responder applications. Basic utility is now satisfied. For tomorrow, makers are focusing on smaller, more efficient engines creating sharper more informative images. Fruitful areas for study remain mainly in characterizing features of an image which cue the user or which enable greater utility and application. Future users must consciously stay in step with commercial motives to assure the widest availability of thermal imaging.



**THERMAL-EYE**


NIST Workshop on  
Thermal Imaging  
Research Needs for  
First Responders

Perspectives from a Detector  
Manufacturer  
Tim McCaffrey  
972-344-5363



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Perspectives from a Detector Manufacturer

- Review the differences between the various detector technologies used in thermal imagers/ IR cameras developed for first responders
- How the resulting images differ among detectors
- Technological advances in detectors; envision the future
- Performance standards that are important for the development of this technology



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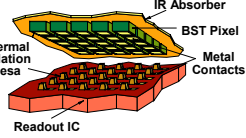

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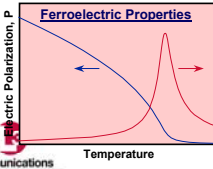
Detector Technologies

Hybrid Pyroelectric Detector




Resonant IR Absorber  
BST Pixel  
Thermal Isolation Mesa  
Metal Contacts  
Readout IC

**Ferroelectric Properties**




Electric Polarization, P  
Temperature  
Dielectric Constant, ε

- 240 × 320 pixels
- 48.5 × 48.5 μm pitch
- 100% optical fill factor
- Polyimide thermal isolation mesas
- Bump bonded to ROIC
- NETD = 0.07-0.08 °C typical, <0.04 °C best



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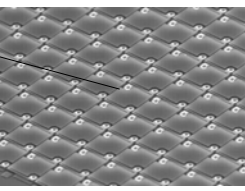
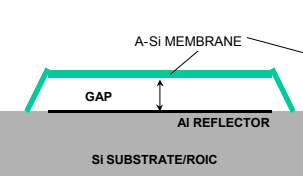
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Detector Technologies

Monolithic a-Si Microbolometer Structure



A-Si MEMBRANE  
GAP  
AI REFLECTOR  
SI SUBSTRATE/ROIC

- Low thermal mass membrane
  - high thermal isolation
  - short thermal time constant: less than a frame
- Resonant Cavity Design for High IR Absorptance
- Pixel resistance (1 V DC detector bias)
- Silicon fab compatible process



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## Comparing Existing Technologies

**Bolometers ...**

- have demonstrated excellent potential for low NETD
- have essentially ideal MTF
- are monolithic and producible
- are limited by spatial noise
- But require occasional "touchup"
- But require factory calibration
- But require precision A/D converters, multiple-field memory, substantial processing capability

**Pyroelectrics ...**

- have minimal spatial noise
- robust in highly variable scene and ambient environments
- require lower-bit A/D converter
- have low MTF
- But requires temperature stabilization
- But pixel size is not readily reducible
- But improvement potential is relatively low

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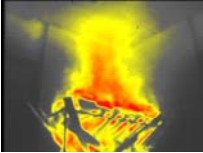
## Image differences



- Other than on the fire ground

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## Image attributes

- Glare obscures figures
- Detail lost in the shadows
- Is the un-burning wall a risk?
- Note the thermocline above the rescuer's Head
- See body and room detail in the presence of flame

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## Advances in Detectors

OEM set priorities for core makers

- Reduce camera, FPA and optics size, weight and cost
- 320x240 advancing to 1024x768
- NETD's approaching 20mK
- Reduced smear; smoother images, crisp images
- Scene temperature ranges over 1000F
- Ambient conditions from -40C to +85C
- Power at the core under 1/2 Watt

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## Performance Standards

- Dynamic Range management
- Wavelength of operation
- MRT vs. NETD et al
- Response of the eye to
  - Spatial noise
  - Temporal noise
  - Clarity, crispness
  - Contrast
- Performance at ambient extremes
  - Endurance at temperature
  - Startup
  - Stability of the Optics
  - Scenes colder or hotter than the camera
- Impact on domestic vs. International mkt.

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